PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Gasification Technologies

05/2006

DEVELOPMENT OF ION TRANSPORT MEMBRANE (ITM) OXYGEN TECHNOLOGY FOR INTEGRATION IN IGCC AND OTHER ADVANCED POWER GENERATION SYSTEMS

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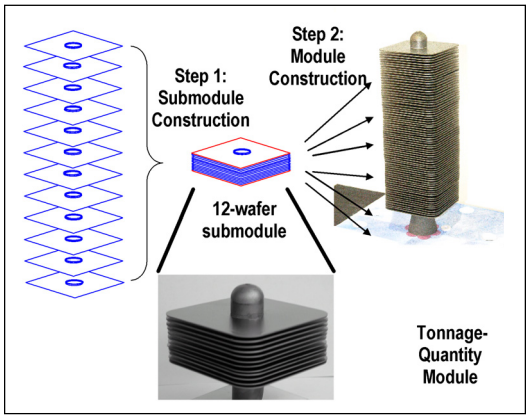
Description



Commercial-Scale ITM Oxygen Modules

Air Products and Chemicals, Inc. is currently developing ion-transport membrane (ITM) oxygen separation technology for large-scale oxygen and advanced power production facilities including gasification. The ITM Oxygen process uses non-porous, mixed ion and electron conducting materials operating typically at 800-900 °C. Ion and electron flow paths occur through the membrane countercurrently, and the driving force for oxygen separation is determined by the relative oxygen partial pressure gradient across the membrane, typically 100-300 pounds per square inch gauge (psig) on the feed side and low to sub-atmospheric pressure on the permeate side. The energy of the hot, pressurized, non-permeate stream is recovered by a gas turbine power generation system. The development of ITMs will reduce the capital costs and parisitic load of air separation systems in comparison to the currently available cryogenic technology. Because air separation is a critical component of the gasification process for power production, any reductions in the cost of this component will in turn, reduce the overall costs of gasification, thereby making gasification more competitive.

Primary Project Goals

The ITM Oxygen project aims to develop, scale-up, and demonstrate a novel air separation technology for integration with integrated gasification combined cycle (IGCC) and other advanced power generation systems for large-scale power production. A three-phase technology RD&D effort will demonstrate all necessary technical and economic requirements for scale-up and industrial commercialization. Phase I objectives focused on materials and process R&D, and the design, construction, and operation of an approximately 0.1-ton-per-day (TPD) Technology Development Unit (TDU). The TDU test data allowed establishment of cost and performance targets for stand-alone, tonnage-quantity commercial ITM Oxygen plants and integration schemes of ITM Oxygen with IGCC and other advanced power generation systems. Phase II and Phase III activities are currently in progress and will test the performance of full size ITM Oxygen modules. The objective of Phase III is to produce high purity oxygen in a 5 TPD engineering prototype facility. These tests also will generate process information for further scale-up to a 25 TPD pre-commercial development facility. In

PARTNERS

Air Products and Chemicals, Inc.

Ceramatec, Inc.

Concepts NREC, Inc.

Siemens Westinghouse

SOFCo Holdings, EFS

GE

The Pennsylvania State University

University of Pennsylvania

COST

Total Project Value
$89,391,332

DOE/Non-DOE Share
$44,695,666 / $44,695,666

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Phase III, a pre-commercial development facility to produce approximately 25 TPD of commercially pure oxygen and qualify process schemes for gas turbine-integrated operation will be commissioned.

Accomplishments

Phase I

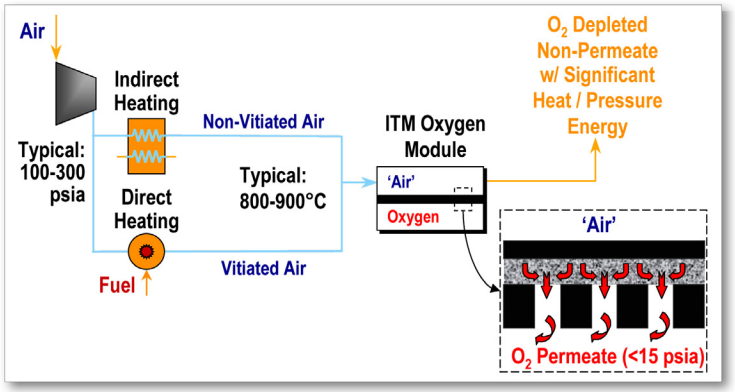
- Developed novel, high-flux materials that withstand the expected commercial operating environment
- Developed cost-effective ITM Oxygen devices
- Demonstrated commercially anticipated performance under real conditions at the pilot scale
- Re-confirmed significant overall cost benefits over conventional, cryogenic oxygen production technology

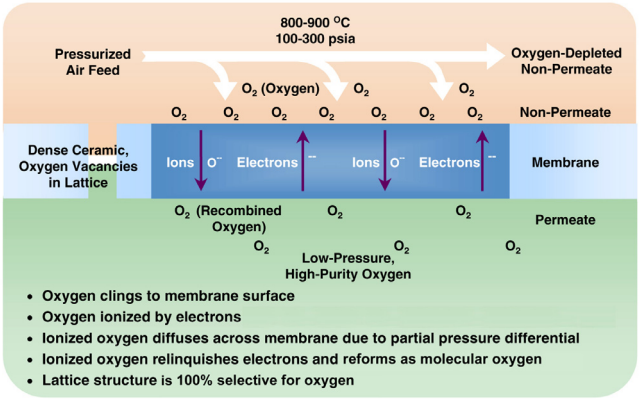
Phase II

- Designed a Subscale Engineering Prototype (SEP) pilot plant to produce up to 5 TPD oxygen to verify the performance of commercial-scale modules.
- Initiated extensive ceramic wafer and module production in the pilot production facility to support the SEP testing campaign.
- Fabricated a thin, cost-optimized, multi-layer ITM structure that achieved oxygen production rates exceeding commercial performance targets at anticipated commercial operating conditions with significant engineering life time.
- Built the first commercial-scale ITM Oxygen separation module.
- Initiated construction of a five ton-per-day engineering-scale ITM Oxygen production prototype, with industrial commercialization projected in the latter part of the decade.

Benefits

The ITM Oxygen production technology is a radically different approach to producing high-quality tonnage oxygen, which will enhance the performance of IGCC and other advanced power generation systems. Process engineering and economic evaluations of IGCC power plants, comparing ITM Oxygen with a state-of-the-art cryogenic air separation unit, projected a one-third decrease in the installed capital cost of the air separation unit and a seven percent decrease in the installed capital cost of an IGCC facility. In addition, ITM Oxygen reduces the power requirement for air separation by approximately 33 percent, which will also improve power plant output and efficiency. Moreover, ITM Oxygen is an enabling module for FutureGen power plants to produce coal-derived synthesis gas (a mixture of hydrogen and carbon dioxide) that can be used to produce hydrogen fuel. Oxygen-intensive industries such as steel, glass, non-ferrous metallurgy, refineries, and pulp and paper would also realize cost, environmental, and productivity benefits as a result of ITM Oxygen.





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